Issue-Based Information Systems for Design

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Abstract

The understanding of planning and design as a process of argumentation (of the designer with himself or with others) has led to the concept of IBIS (Issue-Based Information Systems). The elements of IBIS are *Issues*, each of which are associated with alternative *positions*. These in turn are associated with *arguments* which support or object to a given position (or another argument). In the course of the treatment of issues, new issues come up which are treated likewise.

Issue-Based Information Systems are used as a means of widening the coverage of a problem. By encouraging a greater degree of participation, particularly in the earlier phases of the process, the designer is increasing the opportunity that difficulties of his proposed solution, unseen by him, will be discovered by others. Since the problem observed by a designer can always be treated as merely a symptom of another higher-level problem, the argumentative approach also increases the likelyhood that someone will attempt to attack the problem from this point of view. Another desirable characteristic of the Issue-Based Information System is that it helps to make the design process 'transparent'. Transparency here refers to the ability of observers as well as participants to trace back the process of decision-making.

This paper offers a description of a computer-supported IBIS (written in 'C' using the 'X-Windows' user interface), including a discussion of the usefulness of IBIS in design, as well as comments on the role of the computer in IBIS implementation, and related developments in computing.

Introduction: Argumentation as a Means for Supporting Design

Traditionally, the process of planning and design has been described as a sequence of first understanding the problem, followed by analysis, synthesis and implementation. This model is not a realistic model of the act of design. An alternative understanding ("Second Generation") of the reasoning in the design process and the nature of its problems (Rittel 1970, Rittel/Webber 1970, Protzen 1972) demonstrated that designing is more appropriately understood as a process of argumentation. One of the primary reasons, from the designer's and participants' as well as the public's point of view, is that argumentation tends to help

reducing the chances of overlooking some important aspect of the problem at hand. Debate by a heterogeneous group can also help increase the chances of perceiving connections of the current problem with other problems and of comprehending the ramifications of potential courses of action. Finally, recording of the reasoning during the design process makes the designer's working procedures 'transparent', or explicit, and thereby opens up the decision-making to public scrutiny.

Methodological approaches of the Second Generation are characterized by certain principles, including the recognition that knowledge is distributed in unknowable ways. What this means is that is it not possible to know who might have some information which is important to a design problem. In particular, this principle argues against the idea that there could be such a thing as "experts" who know more about how a problem ought to be solved than those directly affected by the problem. The difficulty raised by this is the realization that you no longer have the false confidence of ignorance. The designers view of the problem is irreversibly changed once he has realized that it is not only possible, but even likely, that someone else has some knowledge about his problem which would be helpful to him, and he doesn't know who that may be. The idea that it is not possible to know who might know something pertinent to a design problem has been referred to as the 'symmetry of ignorance'.

In spite of its name, the principle of the 'symmetry of ignorance' does not imply that no one knows anything about how to resolve a problem. What it is trying to point out is that, without asking, it is not possible to know what others might know that is pertinent to what you are doing. In the extreme case, this principle incapacitates the designer, since in order to be sure that he has all of the information he needed to resolve a problem he would have to ask literally everyone to find out what they know. Faced with this dilemma (assuming they realize its existence) designers have intuitively acted based on the idea that, while it may not be possible to ask everyone, it is probable that those who are most affected by the implementation of a plan are those most likely to know the most about the discrepancies that brought about the plan.

Similarly, the use of argumentation can increase the chances of perceiving connections of the current problem with other problems. The current problem might be treatable in conjunction with a set of other problems, or it can be seen as merely a symptom of a larger problem. The differing participants can see a problem, and its resolution, in dramatically different ways. Argumentation can also take place after a plan, or a set of alternative proposals, has been developed. By inviting debate and criticism, the designer is likely to improve the opportunity to discover and comprehend the ramifications of implementing a plan.

Argumentation helps to make the working procedures of design 'transparent'. Transparency here refers to the ability of observers as well as participants to trace the process of design decision-making. There are several advantages in being able to reconstruct or follow the train of decisions. From the designer's point of view, reconstructing the line of reasoning is useful when, for instance, the designer reaches a dead end with an idea and is wishes to backtrack and then move forward again in a different direction. Designers also return to the documentation in order to defend or justify a plan. For observers, it is helpful to compare the state of the designers knowledge with other participants in order to "pinpoint much more easily any areas of disagreement or discrepancy" (Grant, 1977).

IBIS: Issue Based Information Systems

The Issue Based Information System (IBIS) was developed in 1970 as a method for supporting the decision processes of design through debate and argumentation (Kunz and Rittel). IBIS guides the identification, structuring and resolving of issues raised by designers, and elicits information pertinent to the discourse. It can be used for decision making or mere problem exploration. The process of developing an IBIS encourages looking at situations from many different points of view.

Although there are certain indispensable components, IBIS is actually a family of systems. Because every planning situation is essentially unique, the individual IBIS may be tailored to the current problem. A morphological analysis of the possibilities for the structuring of the IBIS has revealed 21 essential design variables.

It should be emphasized that the IBIS is not a set of standard forms for documenting the design process. It is rather a set of guidelines for developing an individualized recording procedure. As every design problem is unique, and the desireability of recording different types of knowledge varies between projects, the IBIS can be adapted to reflect the characteristics of each problem.

IBIS has been applied in various projects of planning, administration, and teaching (Mueller-Trimbusch 1979, Rittel 1980, Kunz, Reuter and Rittel 1980, Lutes-Schaab, McCall, Schuler and Werner 1985, McCall 1985). It can be operated in hand- or typewritten form, but obviously computer-based versions offer numerous advantages, including simple manipulation of the data-base, simple searching techniques (many orders of magnitude faster), simple retrieval techniques, and networking capabilities. In fact, it is the computer that has made the large-scale IBIS reasonably manageable Several computer versions of IBIS have been developed and used, utilizing micro-computers, mainframe computers, standard data-base programming, text processors, and recently workstations (The first computer versions of IBIS were demonstrated as early as 1974). The complicated network of relationships between issues, positions, and arguments is difficult to record, and painfully time consuming to reconstruct or trace. With the power of the computer in structuring and manipulating a data-base, these difficult tasks are properly delegated away from the designer.

IBIS has been the subject of numerous research efforts. The structure of argumentation in design was treated by Dehlinger and Protzen (1972). A number of studies deal with the theory, structure and design of IBIS (Dehlinger and Protzen 1972, Grant 1977, Mann 1977, McCall 1978, Kim 1980, Grant 1982, Kunz and Rittel 1983, Reuter and Werner 1983)

IBIS is a name which covers many different implementations of methods to support the argumentative nature of design. Each of these has its own characteristics, but throughout all of them there are some essential elements. An IBIS is developed using linked issues, positions and arguments in a structured network of relationships. Additionally, most systems include features such as keyword referencing, chronological sorting, alphabetical sorting by author, keyword, etc., to help in searching and retrieval.

ISSUES

The basic element of the IBIS, or Issue-Based Information System, is the issue. An issue is

stated in the form of a controversial question, about which people may have differing points of view. Some examples of issues taken from architecture might be: "What color should this building be?", "Should another skyscraper be built downtown?" and "What aesthetic style is most appropriate for this building?".

Issues can be categorized according to the types of knowledge they pertain to. These types include: Factual, Deontic, Explanatory, Instrumental, and Conceptual. Factual knowledge has to do with what is, was, or will be the case. The second type category encompasses deontic knowledge (i.e. questions of what ought to be or ought to become the case). The third kind of knowledge is called explanatory knowledge. This type of knowledge explains why something is the way it is, or ought to be. Instrumental knowledge, or knowledge that provides us with the ways we can change something. The final category is conceptual knowledge, which is knowledge on the meaning of words and statements. The various issue types have the form:

Factual:	*Is X the case?*
Deontic:	*Should X be the case?*
Explanatory:	*What causes X?*
Instrumental:	*How can X be brought about?*
Conceptual:	*What do you mean by 'X'?*

Note that each of the types of issues can be dealt with in the past, present or future tense. For example, the factual issues would also include "Was there X?" and "Will there be X?". A reason for wanting to classify the types of issues has to do with the idea that different types of knowledge require different working procedures or treatments.

POSITIONS

A person's response to an issue is called a *position.* In some issues, including all deontic issues (issues of what ought-to-be), such responses include the two opposing viewpoints: 'Yes, that should be' and 'No, that should not be'. In other issues, predominantly instrumental issues (but also in explanatory, factual, and conceptual issues) there is an open list of positions. Thus, for an issue the list consists of alternative courses action, such as:

"*What are the alternative possibilities for X?*"

1. *A is a possibility for X.*
2. *B is a possibility for X.*
3. *C is a possibility for X.*

Every issue permits the *null position,* which means the possibility to argue against the issue itself (the question itself is considered to be irrelevant or otherwise not appropriate).

Positions on issues can be dealt with in several ways. They can be actually assumed by someone in a planning discussion, or they can be introduced for the purpose of investigation just for the sake of argument. In some cases it might be advisable to try to raise as many

positions as the participants can think of in order not to overlook something, while in other cases it is beneficial to deal only with the actual positions of the participants themselves.

ARGUMENTS

The evidence offered to support or oppose a position is known as an *argument.* One position might have any number of arguments to support or object to it, and some arguments may support more than one position (Arguments may pertain to other arguments as well). There are several general modes of responding to a position or other argument:

- *To agree*
- *To concede*
- *To concede 'hypothetically' ("let's assume that you are right...")*
- *To ask "So what?" (What is the significance of your proposition?)*
- *To request justification (How do you know?)*
- *To request further evidence. (Explain!)*
- *To question (Is this so?)*
- *To doubt*
- *To object / contradict*
- *To question or deny the significance or relevance of the proposition (What does that have to do with the problem?)*

Not all of the above wold result in an entry in an IBIS. For example, there is no need to duplicate an argument merely to record an agreement. Which arguments ought to be admissible in a planning discourse is a very difficult question. Because the plausibility of an argument also depends on the whole chain/network of the preceding arguments (not just on the immediate predecessor), a great variety of situations results. Until now, no general system of rules for admissible and plausible argumentation has been developed.

RELATIONSHIPS

The structure of an IBIS is established by various types of relationships of its atoms, issues, positions and arguments. In fact, these relationships are one of the most important features of IBIS. Thus, positions linked to their issues through the verb 'to respond' (A response to a controversial question is referred to as a persons *position* on that issue). Additionally, arguments can be said to 'support' or 'object to' someone's position. When documented, these linguistic relationships structure the argumentation so as to make it traceable, to assist in pointing out where distinct issues may be interrelated, and to assist the designer in discovering where entire types of arguments have been neglected.

While the list of possible types of linguistic relationships may include a large variety of specific terminology, the following provide an adequate starting point:

- To support 'an issue *supports* a position or an argument'
- To object to 'an issue *objects to* a position or an argument'
- To respond to 'a position *responds to* an issue'
- To generalize 'an issue *generalizes* another issue'
- To specify 'an issue *specifies* another issue'

- To refer to 'an issue *refers to* another issue'
- To succeed 'an issue *succeeds* another issue, position or argument'
- To question 'an argument *questions* a position or other argument'

A crucial consideration in an IBIS is that all relationships are 'inverted', which means if one entry points to a second, the second entry is marked to indicate that it is passively linked to the first one. This device enables us to trace back the reasoning that led to a given entry as well as to trace forward the effects which an entry has on successor entries.

Computerized Support of IBIS

A frequent objection against explicit of recording the process of design, either through IBIS or other methods, is that that recording procedures take much, if not most, of the effort away from the real task: designing. Though the IBIS method is intended to do much more than mere documentation, these concerns have led, in part, to an emphasis on increasing the automation of the documentation procedures.

The advent of affordable computing has significantly facilitated the use of IBIS. There are several advantages of using the computer to support the documentation for IBIS. Among the most important are the ease of manipulation of the database for rapid searching and retrieval of records. There are also many bookkeeping tasks that can be delegated directly to a machine, such as sorting (for instance chronologically), and structuring. In a manual IBIS, for example, the authors name would have to be retyped for each record, while the computer is able to note the author, time, and current record number automatically.

The computer is also able to maintain important IBIS support files, such as a list of sorted keywords, without requiring additional effort on the part of the participants. Keyword lists are useful in searching for nests of records on a topic, and the maintenance of a sorted keyword directory in a constantly evolving IBIS would be difficult, if not impossible, by hand.

Another potential advantage of computerizing IBIS is that the networking capability of the machine makes the IBIS more readily available to participants who are separated geographically (Provided it is a networked system with an on-line secretariat -- something we do not presently have). The central IBIS data-base is always current (there are no 'out-of-date' copies) and always available to each of the participants, and the loss of ideas resulting from administrative difficulties is minimized.

The particular computer-based IBIS described by this paper has been developed in the "C" programming language, and is run in the UNIX operating environment using X-Windows. Other examples, using such varied systems as Macintosh's 'HyperCard' and the INGRES database system, as well as other versions in the X-Window environment (Concklin and Begeman, 1988) have been, or are being, implemented.

The significant improvement that the current IBIS program makes over previous versions is in the use of windowing to allow synoptic viewing of the entries of an IBIS. The advantages of windowing in the IBIS include the ability to compare several entries at the same time, the introduction of interactive graphic mapping, intelligent keyword referencing.

In the current version, the IBIS user-interface consists essentially of three window displays: the command window, the record display window, and the text entry window. These correspond to the activities of 'browsing', reading, and entering and editing.

COMMAND WINDOW

The command window contains the menu items for the creation and viewing of the issues, positions, and arguments, as well as options for printing and creating additional links between records. The structure of the 'pull-down' menus is described by the following outline.

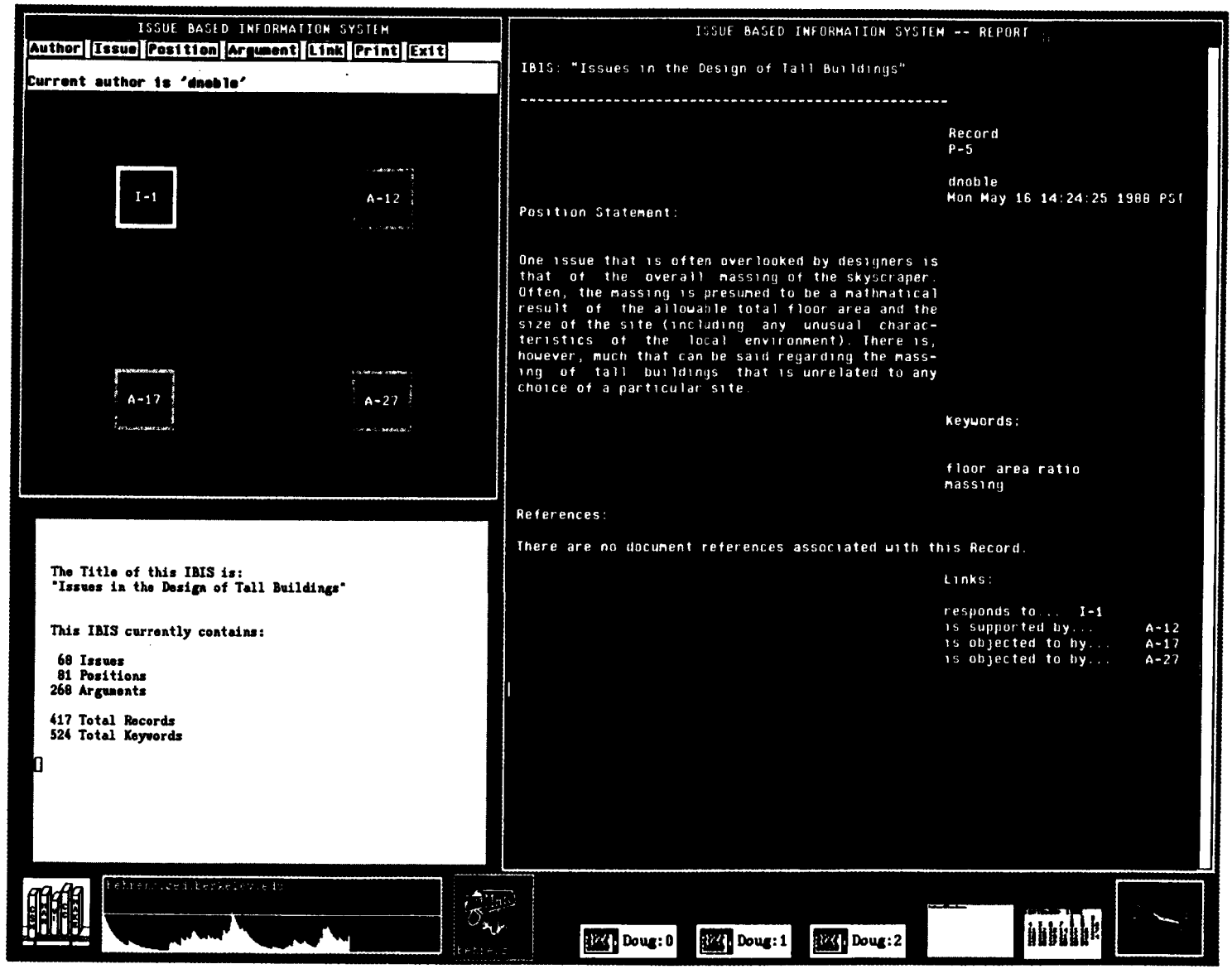
COMMAND	*Options*		
AUTHOR	*Change*	*Show Current*	
ISSUE	*Create*	*Select*	
POSITION	*Create*	*Select*	
ARGUMENT	*Create*	*Select*	
LINK	*Create*	*Destroy*	
PRINT	*Current Record*	*Named Records*	*Linked Records*
EXIT	*Exit IBIS*	*Return to IBIS*	

Also in the command window is an area reserved for displaying an icon representing each of the various records which are directly linked with the currently displayed record. These active icons can be individually selected ('moused') in order to display the nest of records in the immediate area.

RECORD DISPLAY WINDOW

Individual records are displayed as selected in the record display window. The elements of a single record include:

- The title of the IBIS that the record is associated with
- The individual record name (i.e. I-3, P-1, A-5, etc., in our example)
- The author(s) of the individual record
- The date and time when the record was originally created
- The text of the issue, position, or argument
- A list of keywords or phrases related to the content of the record
- A reference to source material such as books, periodicals or other documents.
- The list of links, or relationships, that this record has with other records.


ISSUE BASED INFORMATION SYSTEM
Author
Issue
Position
Argument
Link
Print
Exit
Current author is 'dnoble'
I-1
A-12
A-17
A-27
The Title of this IBIS is:
"Issues in the Design of Tall Buildings"
This IBIS currently contains:
69 Issues
81 Positions
268 Arguments
417 Total Records
524 Total Keywords
ISSUE BASED INFORMATION SYSTEM -- REPORT
IBIS: "Issues in the Design of Tall Buildings"
Record
P-5
dnoble
Mon May 16 14:24:25 1988 PST
Position Statement:
One issue that is often overlooked by designers is that of the overall massing of the skyscraper. Often, the massing is presumed to be a mathmatical result of the allowable total floor area and the size of the site (including any unusual characteristics of the local environment). There is, however, much that can be said regarding the massing of tall buildings that is unrelated to any choice of a particular site.
Keywords:
floor area ratio
massing
References:
There are no document references associated with this Record.
Links:
responds to... I-1
is supported by... A-12
is objected to by... A-17
is objected to by... A-27
Doug:0
Doug:1
Doug:2

TEXT ENTRY WINDOW

When creating or editing a particular record, the recording of text takes place in a separate window. This window becomes active when specifically called to develop a record. Text entry and editing occur in the UNIX operating systems visual editor, 'vi'. Text entry then occurs in stages, since there are actually several distinct and separable parts to each of the records. The description of these stages is documented in the following few paragraphs.

Operating the IBIS

The IBIS program is called by giving the command 'IBIS' followed by the mnemonic for the location of the collection of records for the particular IBIS you are interested in working with. The command must be originally issued in an X-window.

One of the first steps in participating in the development of an IBIS is to review the existing collection of records. The records can be browsed in several alternative ways, most commonly by tracing the threads of relationships to review a 'nest' or area of related issues, or by searching the records through keywords.

The process of developing a record (issue, position, or argument) is relatively straightforward. After selection from the command window menu the option to 'ISSUE: Create', 'POSITION: Create', or 'ARGUMENT: Create' , the remaining steps are prompted by the program. When, for example, 'ISSUE: Create' is selected, the program then opens a file, assigning to it the next entry number of the same type, and records to that file the name of the overall IBIS, the name of the author of the current record and the current date and time. Each of these fields is extracted from previously existing records, such as the login name of the operator, and the abstract of the current IBIS. Once this file has been created, the following steps complete the record and it is displayed in the display window.

- The program prompts for the text of the record, in the form of a question (issue), position on an existing question, or argument regarding some position. This text is written to the text entry window, which was 'opened' by the program concurrently with the prompt requesting the text. When the text of the record is entered, the text entry window (which was opened for use by the 'vi' editor), the operator must signal the program that the text is completed.

- In order to support a second method of searching through the IBIS for records on a particular topic, the program asks each author to provide one or more key words or phrases which can help to identify the contents of the record. These keywords are entered, again in the 'vi' editor, which is closed when the author has entered all of the desired words or phrases.

- Often, an argument comes from an original source other than the current author. In a case like this, it is desirable to maintain a record of the original citation. When the keywords are completed in the previous step, the program then prompts as to whether there are any 'References'. When there are, the text entry window is again opened, and a bibliographic reference will be prompted for.

- The final step in the creation of a record involves linking the new record to previous ones. If the new record is a position, then that position should be linked to the issue to which it responds. Similarly, arguments are connected with positions or other arguments. The program prompts the user to identify the type of relationship shared by the two records to be linked. Frequent relationships, such as 'This argument *supports* that position' or 'This position *responds to* that issue', are offered as defaults, but the author is also offered the option to identify his definition of the relationship shared by the two records. When one relationship is selected (relationships here refer to the 'link' between two records), the active link is transcribed on the current record (argument #3 *supports* position #6), and the passive link is transcribed to the record being linked to the current one (position #6 *is supported by* argument #3).

- Each record may be linked in this manner to any number of other records, but there must be at least one link to one other record. The program will continue to accept links to as many records as the author of the current record deems appropriate. After indicating all of the proposed links to other records, the current record is quickly formatted and displayed, and the activities of browsing and record entry can begin again.

There are several effective methods for scanning or browsing through an IBIS. Obviously, the traditional keyword index will assist in searching for topics of particular interest which can be identified through specific terminology. It is also often helpful to search an IBIS for records by specific individuals, in an attempt to understand the worldview of another participant. Beyond these traditional techniques, however, is the structure of relationships that link the various issues, positions and arguments. These relationships provide links between often diverse nests of issues in an IBIS, and provide a designer with new knowledge about the interdependency of two seemingly disparate areas.

Conclusion

The fundamental idea of IBIS is that of the encouragement and documentation of argumentation in an effort to increase the opportunity for the appearance of some information which the designer may not have discovered by himself, and to provide a tool for making this process explicit and understandable. It is important to note that this method does not guarantee either that all issues related to the topic will be brought out, nor that perhaps some issue of overriding importance may still be overlooked. Further, having reviewed the positions and arguments given on an issue or set of issues, there is no guarantee that consensus can be achieved among the participants. The intent of IBIS is not to achieve consensus, but to stimulate discussion.

It is the computer that makes the large-scale IBIS reasonably manageable. The complicated network of relationships between issues, positions, and arguments is difficult to record and painfully time consuming to reconstruct or trace. With the power of the computer in structuring and manipulating a database, these difficult tasks are properly delegated away from the designer.

The version IBIS described in these pages is in many ways merely an introduction to the potentials of the computer and windowed environments to support the argumentative nature of the design process.

Future Work in the Development of IBIS

As is usually the case with any computer-supported approach, there is much room for improvement and modification of the currently implemented IBIS. Some improvements are already envisioned, such as improved use of the issue map for searching and retrieving records, and the integration of graphics, both pre-existing and user generated. Development of these and other additions to the IBIS are already underway. But there are also entire fields of development at the conceptual scale that are only just beginning to be researched. Among these are the ideas of automated position and argument entry based on a model of rhetorical processes (automated 'suggestion' of the next question, and the logic of the next entry), and the development of evaluation techniques that can be integrated into the IBIS structure.

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